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Forest Health Protection
Pacific Southwest Region

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To: Field Manager, Bureau of Land Management, Eagle Lake Field Office, Susanville, CA

Subject: Evaluation of Bark Beetle Activity in the Bailey Creek Thinning Project (FHP Report NE07-04)

At the request of Wade Salverson, Forester, Eagle Lake Field Office, BLM, I conducted a field evaluation of the Bailey Creek thinning project on July 13, 2007. The objective was to evaluate the current bark beetle activity occurring within and adjacent to recently thinned stands and to evaluate the potential for future bark beetle caused tree mortality.

Background

The Bailey Creek thinning project is located on the northeast facing slopes of Fredonyer Peak, about 5 miles northeast of Eagle Lake, CA, at an elevation of 6500 feet (T33N, R12E, Sec. 2 and 3; T34N, R12E, Sec. 34 and 35). Annual precipitation for the area is approximately 20 - 25 inches. The forest is a typical eastside pine type consisting mostly of Jeffrey pine (*Pinus jeffreyi*), ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*) and western juniper (*Juniperus occidentalis*). Curlleaf mountain mahogany (*Cercocarpus ledifolius*) is also scattered throughout the project area. The understories in most of the higher elevation stands in the Bailey Creek area contain thickets of small white fir with scattered ponderosa and Jeffrey pine and western juniper (Figure 1). Management objectives for the site are to reduce stand density to a point where crowns are spaced about 20 – 30 feet apart and to reduce surface and ladder fuels. This will decrease the risk of stand replacing wildfire and improve the health of the residual trees; thereby reducing bark beetle caused tree mortality. Past harvest activities include a green timber sale of large pines in 1960, a green timber sale in 1988 and two salvage sales in the mid and late 1990's. The salvage sales were in response to large numbers of pine and fir dying as a

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result of the high stand density, drought and bark beetle attacks.

Observations

Several ponderosa pines located within and adjacent to one of the thinned units have recently faded as a result of mountain pine beetle (*Dendroctonus ponderosae*) and western pine beetle (*Dendroctonus brevicomis*) attacks sustained in the fall of 2006 (Figure 2). A couple of currently infested green crowned trees were observed in this area as well.

Figure 1. Dense white fir understory with many downed logs.

Figure 2. Ponderosa pine mortality caused by over-stocking, drought and bark beetle attacks.

A few trees within this same unit have recently been attacked by the red turpentine beetle (*Dendroctonus valens*) as a result of harvest activity injuring roots and tree boles. These attacked trees, found mostly along skid trails, are still green and do not show signs of being attacked by other bark beetles.

In a second thinned unit, which was predominantly Jeffrey pine, there were no signs of bark beetle activity. This unit appeared to be much more open prior to treatment than other units within the project area and tree bole and root damage during felling and skidding was minimal.

Stand density and fuel loading outside of the treatment units are very high as opposed to treatment areas. Stand density in thinned units has been effectively reduced with residual stocking at approximately 80 sq. ft. / acre.

Logging slash is being removed from the units and consolidated at the landings. Signs of pine engraver (*Ips pini*) activity were not observed in trees growing next to these landings.

Stumps created as a result of harvest activities are not being treated with Sporax to prevent new infections by the fungus *Heterobasidion annosum*, the causal agent of annosus root disease. Heart rot was observed in white fir stumps within the treatment area, indicating the potential presence of the fir type, or S-type, annosus root disease. However, no signs of the pine type, or P-type, annosus root disease were found (Appendix A).

Discussion and Recommendations

Stand density reduction treatments occurring within the Bailey Creek area are effectively reducing tree competition for the limited water and nutrients found in this eastside pine forest and have greatly reduced the risk of future tree mortality caused by drought and bark beetles. However, it will be a few years before these trees can take full advantage of their extra growing space by increasing their root systems and crown volumes. If the current dry conditions continue, some additional bark beetle activity could be expected within treated units over the next couple of years and untreated stands could experience high levels of bark beetle caused mortality.

Trees that are injured during harvest activities are especially attractive to the red turpentine beetle due to the fresh pine resin associated with wounds to the roots and bole. Red turpentine beetle attacks alone typically do not result in tree mortality and most trees attacked within the Bailey Creek harvest units should survive. However, these trees will remain at a high risk of being attacked by the western pine and/or mountain pine beetle at least through the end of this season. To limit red turpentine beetle attacks, injury to residual trees during future harvest activities should be minimized as much as possible.

The prompt removal of green pine slash has insured that top-kill or whole tree mortality caused by the pine engraver beetle will be extremely limited within treatment units. This practice should also be extended to the large slash piles at the landings. If slash piles at landings are not chipped or removed within 5 - 6 weeks of being created, there will be an increased risk of top-kill or mortality of adjacent pines due to pine engraver beetles breeding in the slash and than emerging to attack adjacent trees. Past observations by U. S. Forest Service and Forest Health Protection personnel have shown that under normal precipitation conditions these types of large slash piles are generally of minor concern mostly because residual trees are generally not in a stressed and susceptible condition; however, due to the extremely dry conditions that exist within the Bailey Creek area, the potential for top-kill or mortality of trees adjacent to slash piles is greatly increased and timely processing and removal of this material from these landings is highly recommended.

It is also recommended that a registered borate compound be applied to all freshly cut conifer stumps >14" within the Bailey Creek project and any future eastside pine thinning projects. Since it appears that the presence of annosus root disease is limited within the stand, this treatment is recommended in order to reduce the chance of new infection centers being created through harvest activity. The establishment of new root disease centers could lead to significant tree mortality, creating stand openings that may or may not be compatible with long-term management objectives.

Forest Health Protection may be able to assist with funding for thinning and removing green material from overstocked areas on BLM land on a competitive basis. If you are interested in this funding please contact any of the Forest Health Protection staff for assistance in developing and submitting a proposal through the Department of the Interior.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431.

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Appendix A – Insect and Disease Information

Western pine beetle

The western pine beetle, *Dendroctonus brevicomis*, has been intensively studied and has proven to be an important factor in the ecology and management of ponderosa pine throughout the range of this host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches dbh. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latitude and elevation, there can be from one to four generations per year.

Evidence of Attack

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. The pitch tubes are red-brown masses of resin and boring dust. Relatively few, widely scattered, white pitch tubes usually indicate that the attacks were not successful and that the tree should survive. Pheromones released during a successful attack attract other western pine beetles. Attacking beetles may spill over into nearby apparently healthy trees and overwhelm them by sheer numbers.

Life Stages and Development

These beetles pass through the egg, larval, pupal and adult stages during a life-cycle that varies in length dependent primarily upon temperature. Adults bore a sinuous gallery pattern in the phloem and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem and then mine into the middle bark where they complete most of their development. Bluestain fungi, introduced during successful attacks, contribute to the rapid tree mortality associated with bark beetle attacks.

Conditions Affecting Outbreaks

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the West since 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles. Information from surveys initiated in the 1930s indicates that there were enormous losses attributed to western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size through successive beetle generations as is typical with Jeffrey pine beetle. Rather, observations indicate that emerging beetles tend to leave the group kill area to initiate new attacks elsewhere.

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing outbreaks. When healthy trees undergo a sudden and severe moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant amounts of resin, which pitch out attacking beetles, but when deprived of moisture, stressed trees cannot produce sufficient resin flow to resist attack. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation or protracted drought periods; or any condition that reduces that ability of the roots to supply water to the tree, such as mechanical damage, root disease, or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle. Woodpeckers and predaceous beetles are natural control agents when beetle populations are low.

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae,* attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with thick phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from the pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include nematodes, woodpeckers, and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and pine mortality increases.

Red Turpentine Beetle

The red turpentine beetle, Dendroctonus valens, occurs throughout California and can breed in all species of pines. It normally attacks injured, weakened or dying trees and freshly cut stumps. The adults are attracted by fresh pine resin. They often attack wounded trees in campgrounds or following logging, trees scorched by wildfire or prescribed burns, lightning-struck trees and root-diseased trees exhibiting resinosis.

Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. On severely stressed trees or during periods of drought, attacks may occur underground

on the main roots up to 15 feet from the bole and also on the bole to a height of 10 feet. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. The larvae feed in a mass and destroy an area of cambium ranging from 0.1 to 1.0 square feet. Attacks do not always kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines.

Attacks occur throughout warm weather and peak at mid-summer. The number of generations varies from two years for a single generation at the coldest portions of its range to two or three per year in the warmest.

Attacks can be minimized or prevented by avoiding soil compaction and injury to standing trees during logging or construction and also by insecticide application to high value trees.

Pine Engraver Beetles

Pine engraver, Ips spp., attacks have been recorded on most species of pines in California. These beetles kill saplings, poles and sawtimber up to about 26 inches dbh and the tops of even larger trees. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire or the attack of other insects. If fresh slash is available in the spring, pine engravers may build up in an area and cause localized mortality or top killing by mid-summer.

Attacks are made with the coming of warm weather in the spring. Attacking males bore nuptial chambers in the inner bark and release a pheromone which attracts other beetles to the attack site. If many beetles are attracted, they may attack nearby trees and cause a group kill. Within a day or two of the attack by the male, two to five females enter the nuptial chamber and after mating, each female bores an individual egg gallery which lightly scores the sapwood. The size and pattern of the combined gallery pattern is often diagnostic of the species of Ips involved. The galleries are kept open by beetles pushing boring dust out through the entrance hole. Red boring dust collecting in bark crevices or spider webs is diagnostic of a successful attack. Eggs are laid in niches along the sides of the galleries. Larvae hatch from the eggs and feed in the phloem. They eventually pupate in cells at the end of their larval mines and transform to adults.

A new generation is produced in as little as 6-8 weeks in the spring to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon which Ips species is involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as drought or logging disturbance. Tree killing frequently occurs where green pine slash, which serves as breeding habitat is left untreated during spring and summer. To be suitable as pine engraver breeding habitat, pine slash must have bark from 1/8 to 1 inch thick (usually 3 to 26 inches diameter), must have succulent cambium and must remain moderately cool during the development period.

Fresh pine slash caused by thinning, dwarf mistletoe control work, construction or winter storm breakage can be modified in a number of ways to make it unsuitable for pine engraver breeding. One approach to minimizing damage is to schedule slash-generating activities mostly between mid-July and late-December, when the slash has a high probability of drying out, heating up, or spoiling before the beetles can complete their development. Utilization of the cut material to the smallest possible diameter will minimize the amount of breeding material available to engraver beetles. If green pine slash must be created during the spring and early summer, slash treatments are available to prevent the buildup of pine

engraver populations. Because pine engravers can complete their development in about a month under ideal conditions, treatment should be carried out soon after cutting to be effective.

Slash treatment methods which generally work well include chipping, lopping and scattering slash in sunny areas to heat it up, crushing or mashing slash with logging equipment to make it unsuitable for pine engraver breeding, or piling and burning the slash within a month of cutting. Broadcast burning the slash might work if it could be done without damaging the residual stand. A method which has worked during the summer in hot climates is to pile slash in a sunny area and tightly cover the pile with clear plastic. If the temperature under the bark of slash in all parts of the pile reaches 120^{o}F, all brood currently in the pile will be killed. Lower temperatures will not be effective and, where successful, this method will not prevent reinfestation of slash piles. Because most pine engraver attacks occur within a quarter-mile from the location where the beetles emerged, high value pines can be given some protection by removing fresh pine slash to areas which do not have pines.

Two practices which should generally be avoided are piling fresh pine slash without further treatment, and allowing slash to touch or remain near valuable leave trees.

Annosus Root Disease

Heterobasidion annosum is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of *H. annosum* have major differences in host specificity. All isolates of *H. annosum* from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir and giant sequoia have been of the "S" group. This host specificity

is not apparent in isolates from stumps; with the 'S' group being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.